Progress Update

- Using carbon foil run to determine the z position of HyCal

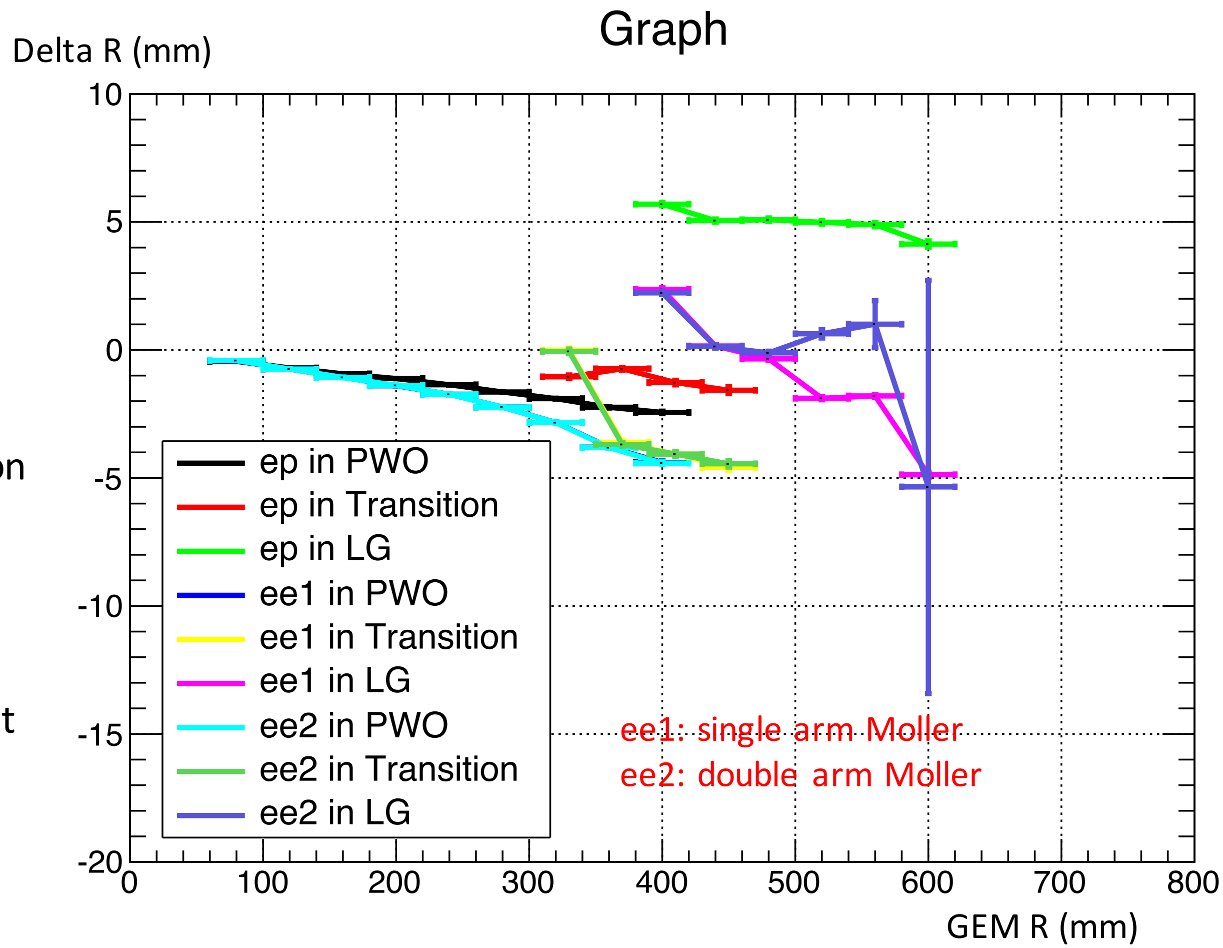
- Complexity in the z position of HyCal clusters
  - For each reconstructed HyCal cluster, there is a “hidden” z coordinate associated (not necessary the surface of a module)
  - Energy dependence: high energy particles go deeper into the calorimeter
  - HyCal is made of two different material, LG surface is 10.12 cm more upstream than PWO

- The goal is to find a common z plane on HyCal, so that the interaction vertex, GEM hit and HyCal hit fall on the same straight line

- First approach:
  - based on the angular correction function in PrimEx
  - After project all hits onto the ”shower z plane”, Look at distribution of delta r (hycal R – GEM r) as a function of GEM r. The mean value should be consistent with 0

Finding the Shower Z Plane

- No correction applied
- Common z plane assume to be 5817 mm
- ep and ee1 are selected based on 3 sigma cuts around expected energy
- ee2 requires delta phi < 20 deg, in addition to 3 sigma energy cut



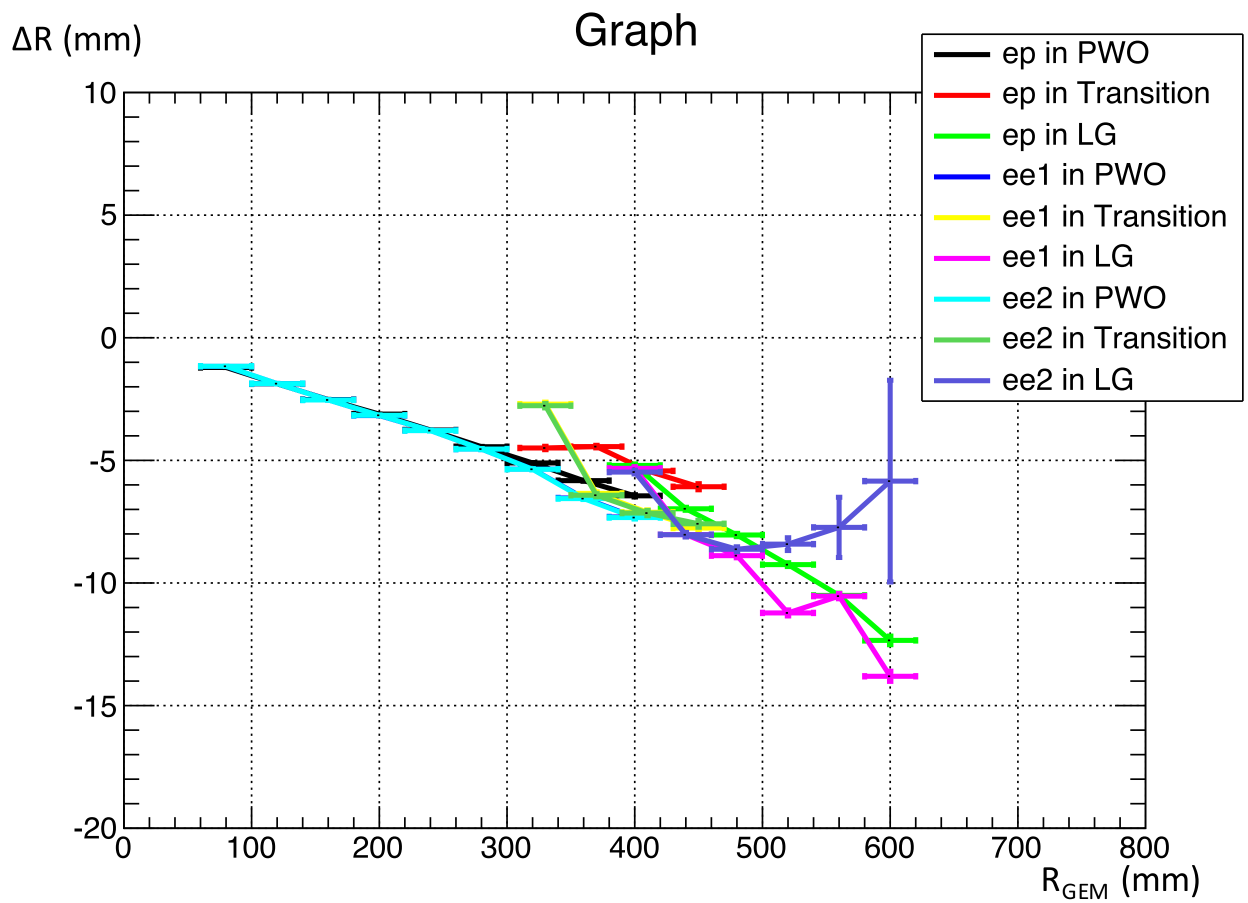
Finding the Shower Z Plane

- PrimEx angular correction (my understanding):
  - The distance between module surface and the measured z position of a HyCal cluster is given by: $dz = X_0 * \ln(1 + E_R/E_c)$
  - E_R is the reconstructed cluster energy
  - X_0 and E_c are two hard-coded parameters
  - X_0 is 26.7 (8.6) cm for LG (PWO), very close to the radiation length of TF-1 type lead glass and lead tungstate
  - E_c is 2.84 (1.1) MeV for LG(PWO), very different from the critical energy of the two materials
- We can use the surface of PWO as the common z plane
- From PDG, the maximum shower depth is given by:
  - $t_{max} = X_0 * \ln(E_R/E_c) - 0.5$ for electron

Finding the Shower Z Plane

- After apply the correction, project all hits to plane at 5817mm

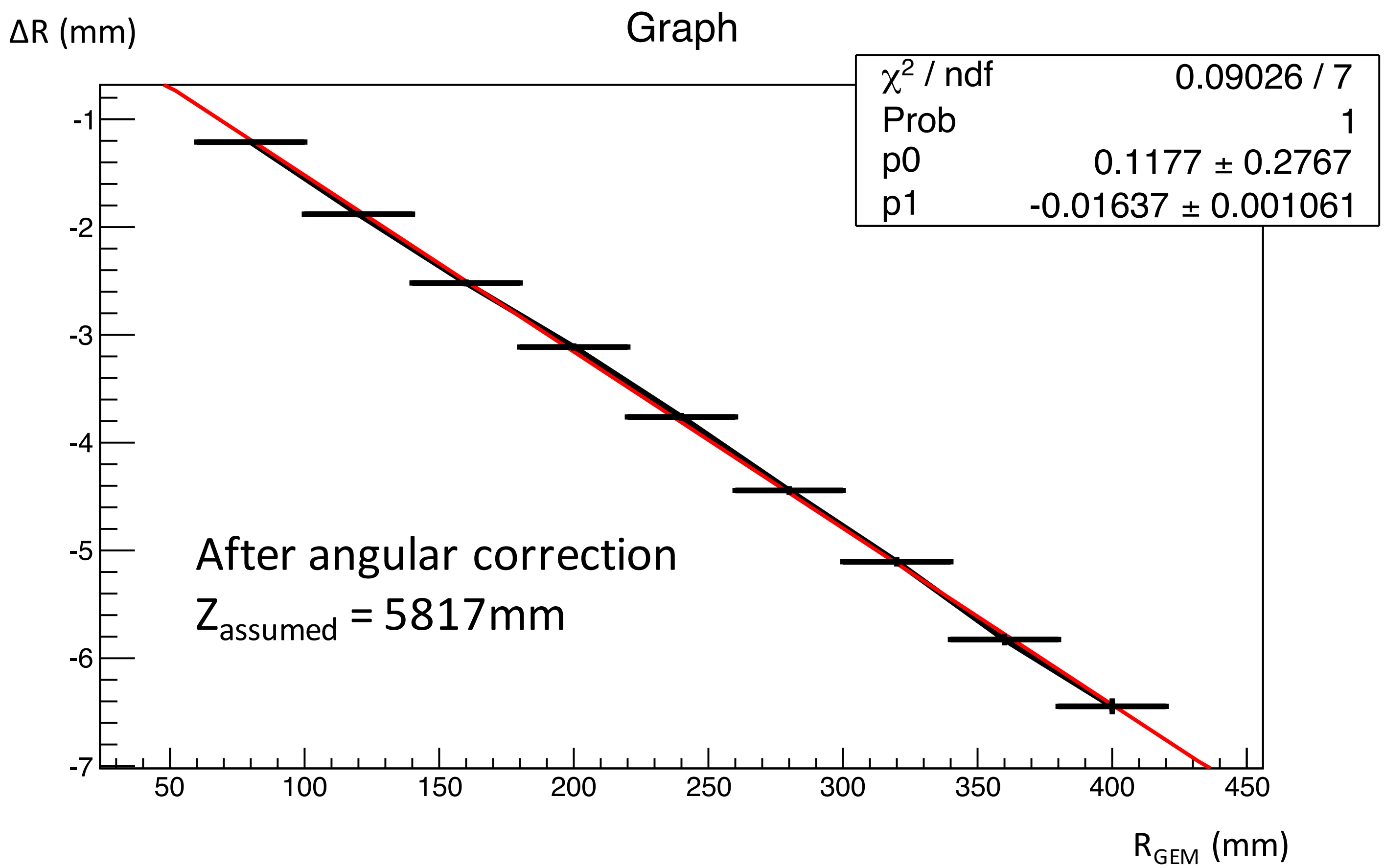
- If all points fall roughly on a straight line, then it is possible to be corrected by shifting the z coordinate of the plane



Finding the Shower Z Plane

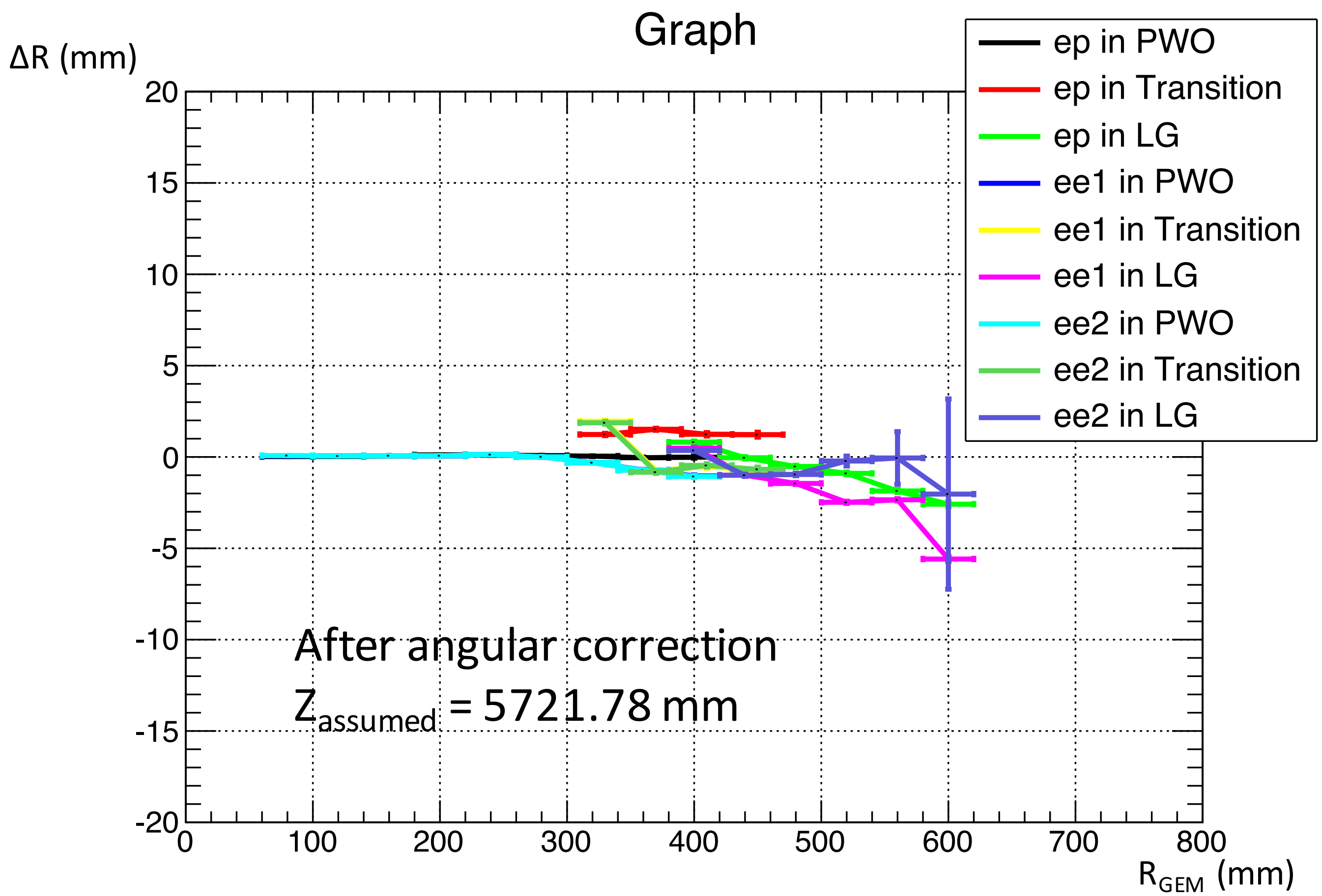
- The slope of the straight line tells how much the actual common z plane (z_{real}) deviate from the assumed common z plane ($z_{assumed}$)
  - $\Delta R = \tan(\boldsymbol{\theta}) * \Delta z$
  - ΔR is $R_{HyCal} – R_{GEM}$
  - Δz is $z_{real} - z_{assumed}$
  - $\tan(\boldsymbol{\theta})$ is approximately $R_{GEM} / z_{assumed}$
  - So $\Delta R = (R_{GEM}/z_{assumed}) * \Delta z$ or $\Delta R = (R_{GEM}) *(\Delta z/z_{assumed})$

First order polynomial fit for ep in PWO



Z_{real} - $Z_{assumed}$ = -0.01637 * $Z_{assumed}$ so Z_{real} is 5721.78 mm

Finding the Shower Z Plane



- From PDG, the maximum shower depth is given by:
  - $t_{max} = X_0 * \ln(E_R/E_c) - 0.5$ for electron
- Test this function form using the PrimEx parameters